

# How Much of South Korea's Growth Miracle can be Explained by Trade Policy?

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<sup>1</sup>The views expressed here are those of the authors and are not necessarily reflective of views of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

# Key Features of South Korea's Growth Miracle

Variable	1963	1995
Manuf. VA/L in Korea relative to G7	0.17	0.40
Manuf. export (share of manuf. GDP)	0.15	0.92

# Korea Manufacturing Growth Accounting

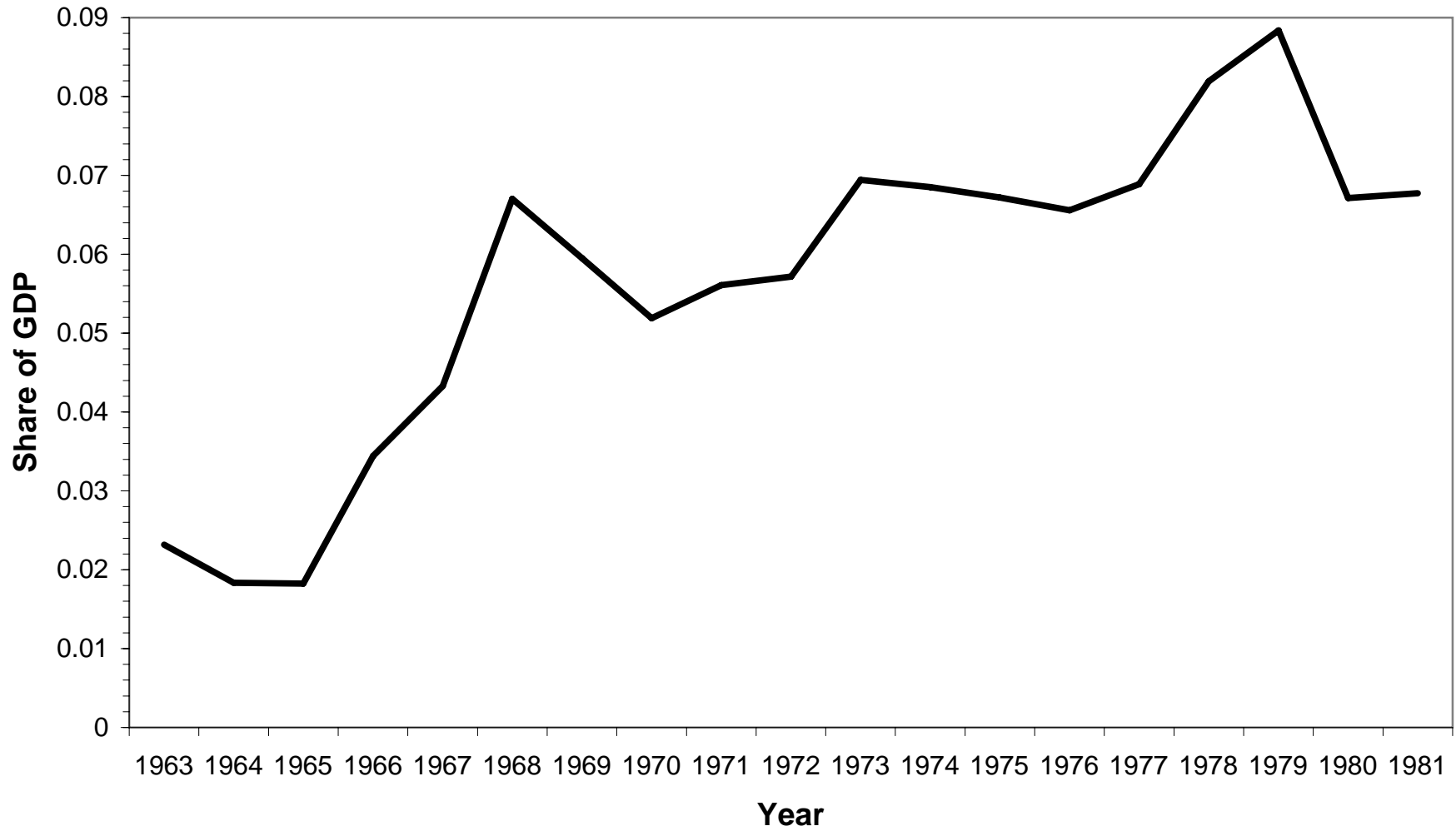
$$Y = AK^\alpha L^{1-\alpha}; \alpha = 0.4$$

Hall-Jones approach

Variable	1995 (relative to 1963)	Share of (ln) growth accounted
Manuf. VA/L	8.7	
Manuf K/Y	1.5	0.13
Manuf TFP	6.5	0.87

Also, the nature of trade changed ...

## South Korea's Capital Goods Imports



Source: IMF Int'l Financial Statistics (GDP), Bank of Korea  
Economic Statistics Yearbooks (Capital Goods Imports)

# Vertical Specialization

Country 1

Intermediate goods

Country 2

Domestic intermediate goods

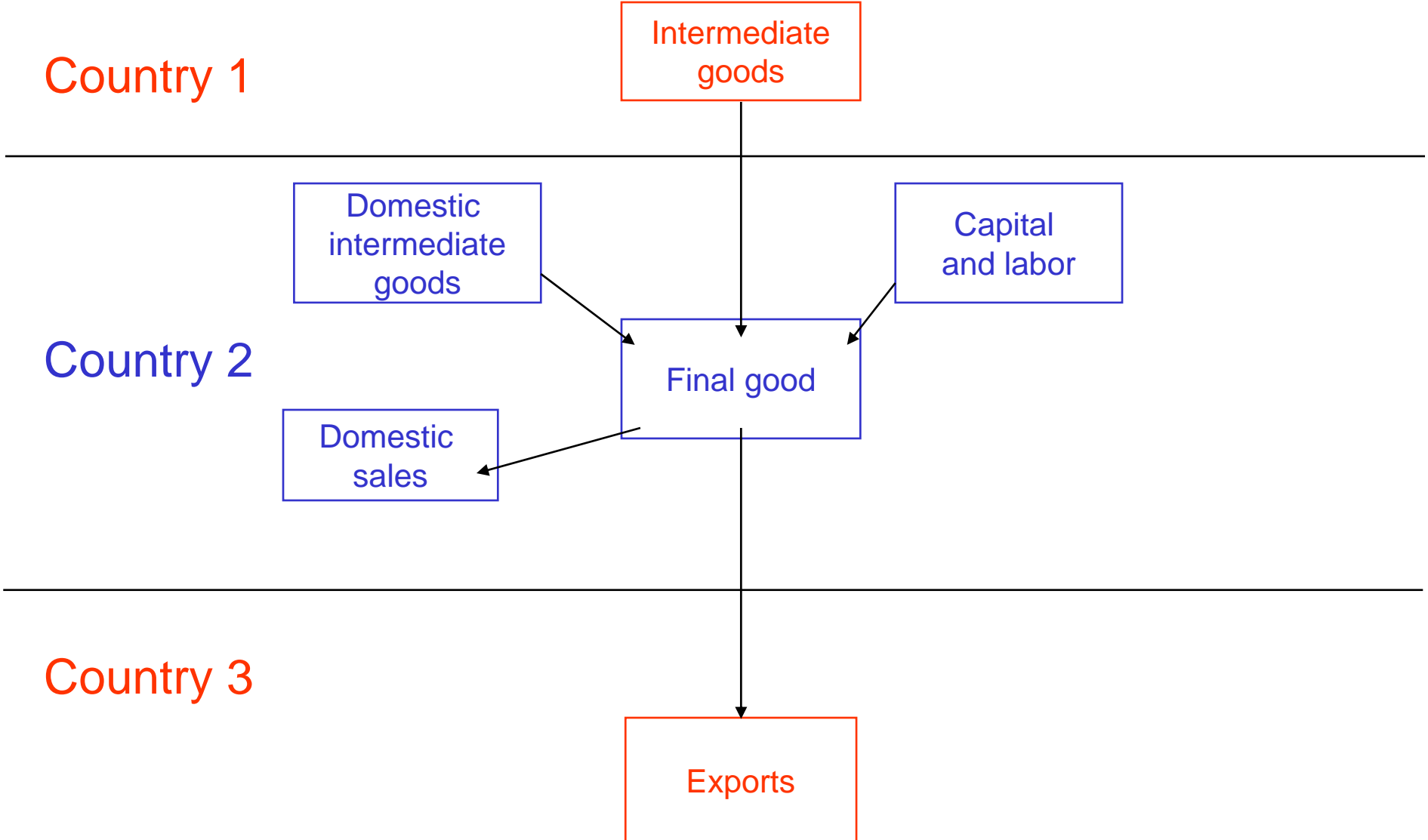
Capital and labor

Final good

Domestic sales

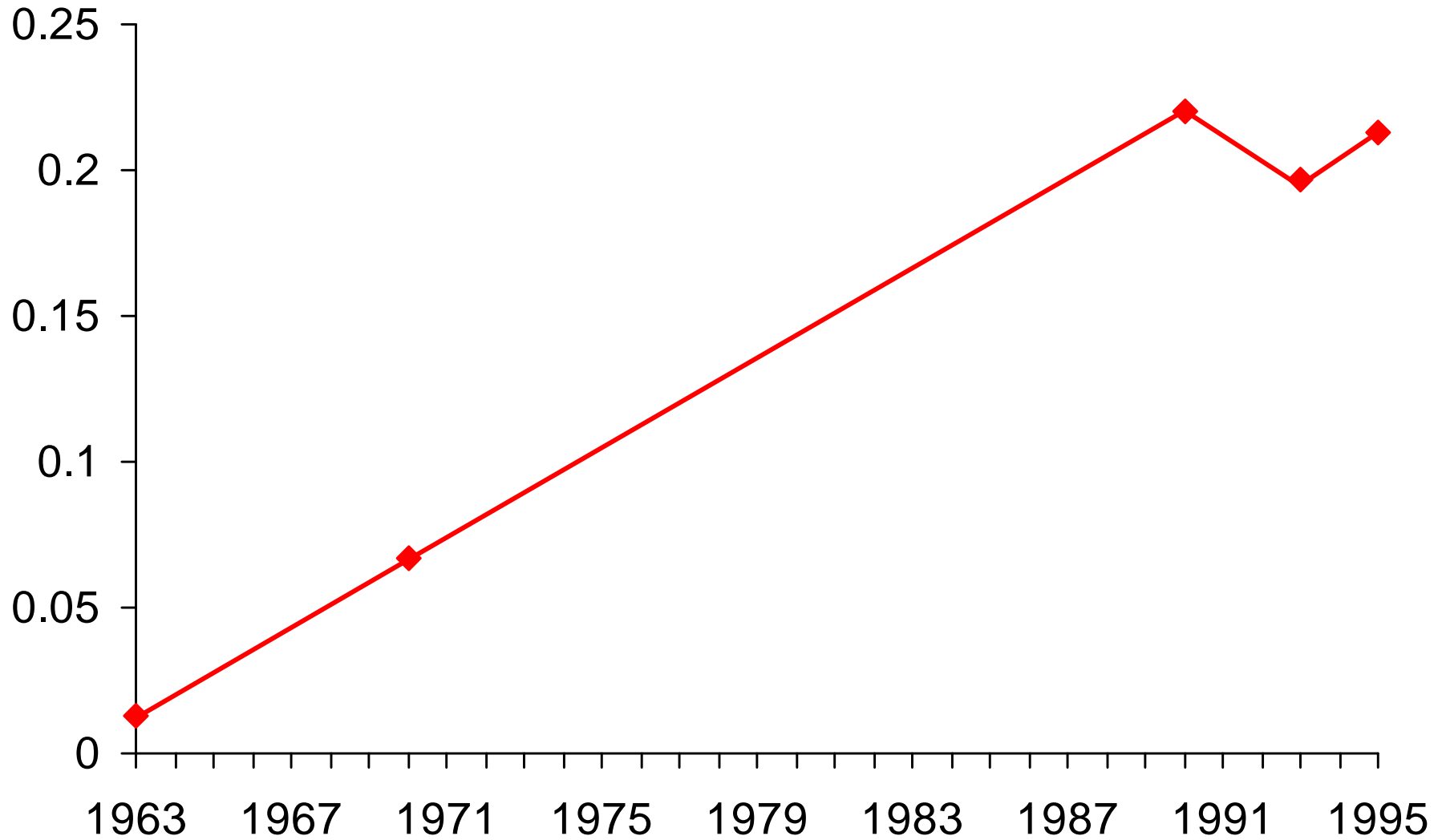
Country 3

Exports



# Korea's Vertical Specialization Exports

Share of merchandise GDP



Source: Bank of Korea; Input-Output Tables, selected years

# South Korea's Trade Policy Reforms

Trade policies among the most important reforms in the early 1960s. Hong (1979) documents 38 reforms geared towards exports including:

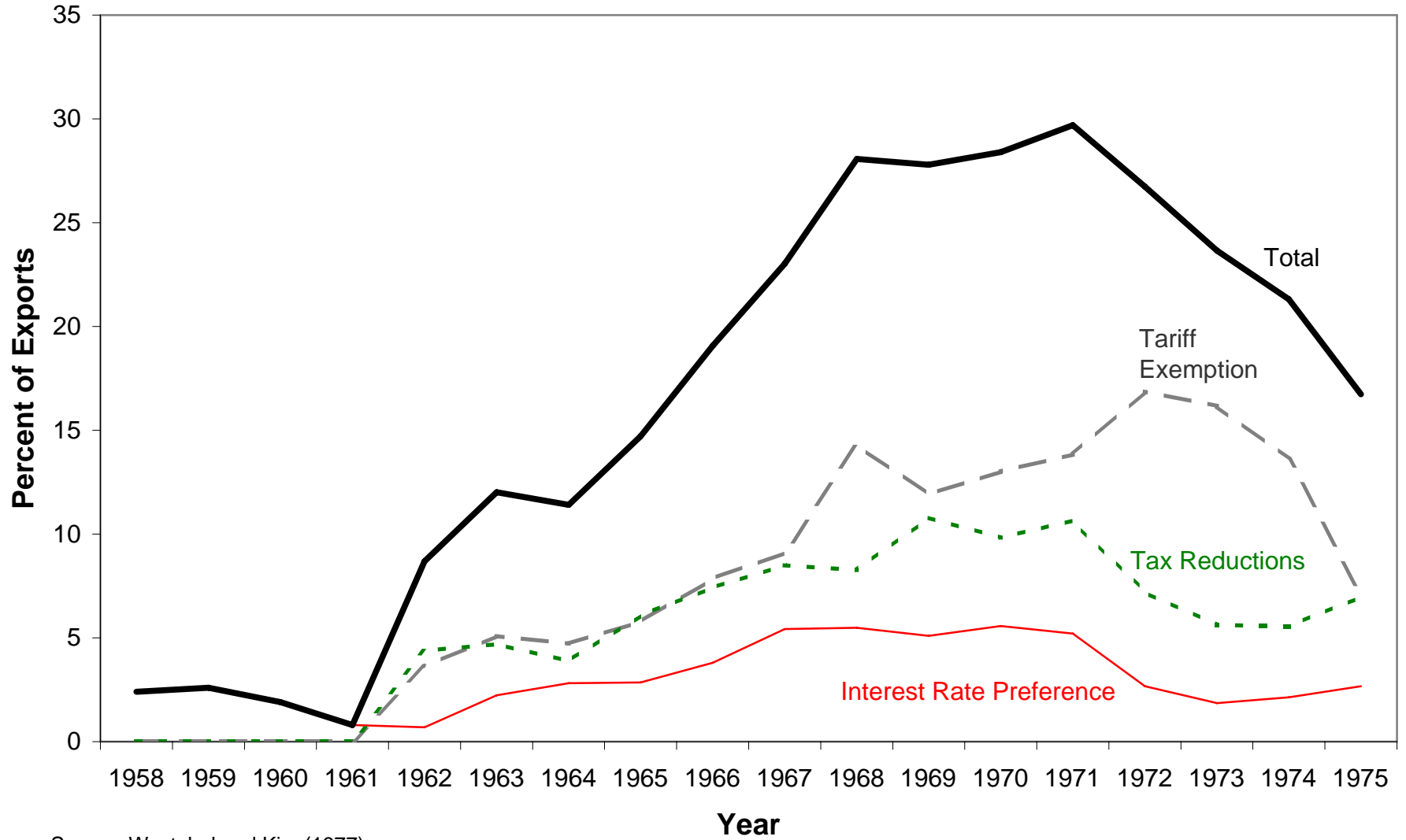
- 1 Tariff exemptions on imported inputs and capital goods used for export production
- 2 (1970+) Broad reductions in tariffs
- 3 Lower indirect and direct taxes for exporters
- 4 Lower interest rates on loans funding exporters
- 5 (1970+) Reduction in quotas

# South Korea's Trade Policy Reforms

- Tariff exemptions were the most important
- Our paper will focus on the first two reforms



## South Korea's Export Preferences



Source: Westphal and Kim (1977)

## Broad Goal and Methodology

- How much of Korea's growth miracle was due to its (and the world's) more open trade policies?
- We develop and calibrate a model of trade and growth and we simulate the effects of the key trade reforms.
  - Model combines neoclassical growth with neoclassical trade. Two additional dimensions are trade in investment goods and multi-stage production.
  - Trade policies include Korea tariff exemptions, Korea broad tariff reductions, as well as G7 tariff reductions under Kennedy and Tokyo rounds of GATT.
- Results demonstrate that model can explain about 15 percent of the "catch-up" of Korea to G7; trade in investment goods and multi-stage production account for virtually all of the model's result.

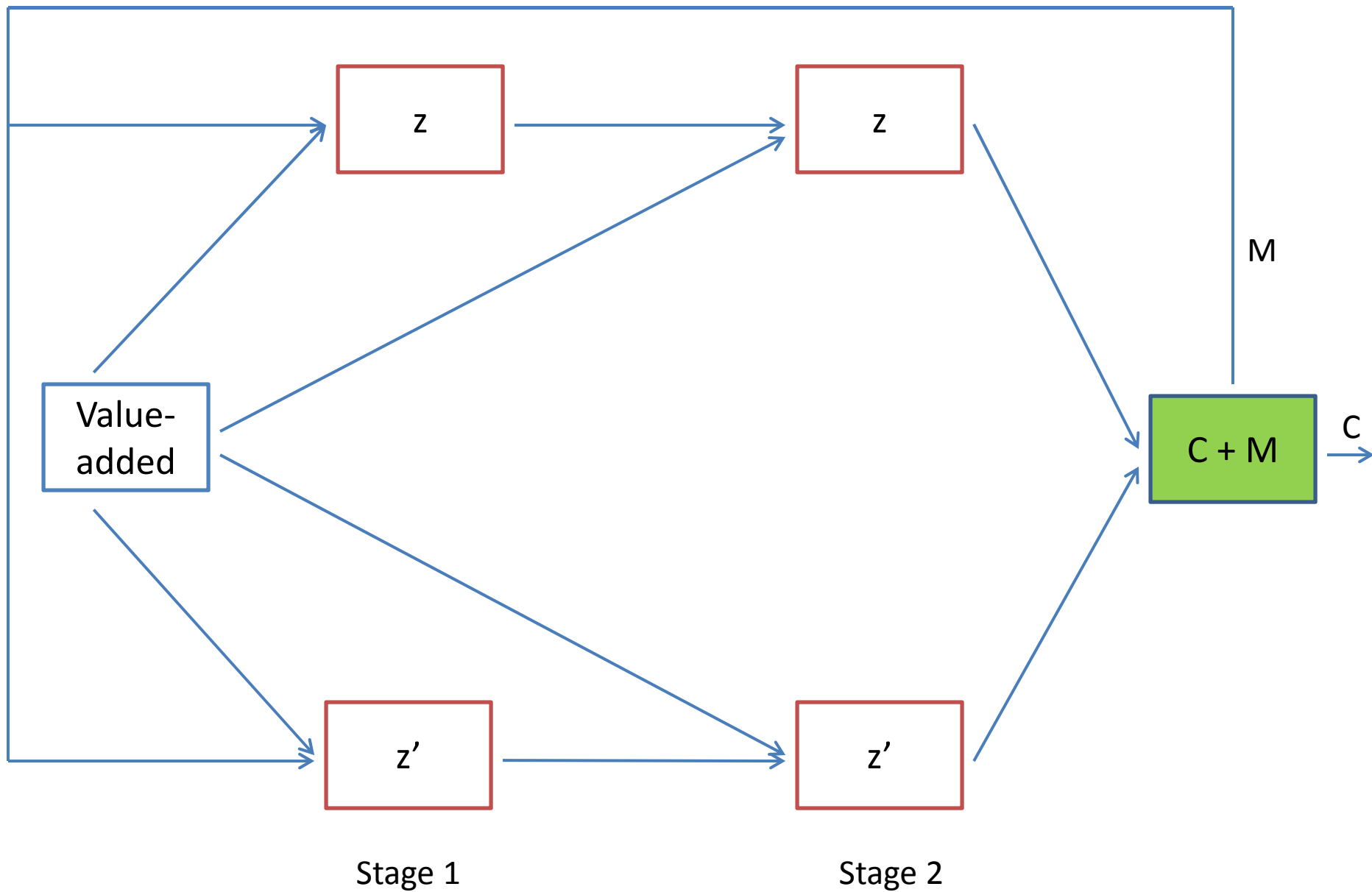
# Themes Underlying Our Approach

- Theme 1: Model enables us to highlight channels through which trade liberalization increases per capita income and trade
  - 1 Specialization
  - 2 Capital accumulation
- Theme 2: To assess aggregate importance of trade policy over time, need to do an aggregate, quantitative analysis over time.
- Theme 3: Use Korea as case study to assess the importance of trade policies on growth. If trade policy doesn't matter for Korea, it may not matter at all.

# Main Ingredients

- Two countries,  $H$  and  $F$
- Two factors: labor and capital
- Two sectors: consumption and investment
  - Each sector consists of a continuum of tradeable goods
  - Individual consumption goods are made in two stages; individual investment goods in one stage
  - Production requires labor, capital, and intermediates
- Motive for trade is Ricardian
- Ad valorem trade costs: tariffs, transport costs, "other" trade costs
- Representative household in each country
  - Supplies labor and rents capital to firms
  - Chooses consumption and investment paths

# Consumption Goods Production Structure



# Production and Technologies: I

- Stage 1 consumption goods are produced from capital, labor, and aggregate intermediate:

$$y_{i1}(z) = (A_{i1}(z)k_{i1}(z)^\alpha l_{i1}(z)^{1-\alpha})^{1-\theta_1} M_i(z)^{\theta_1} \quad z \in [0, 1]$$

- Stage 2 consumption goods are produced from capital, labor, and stage 1 good:

$$y_{i2}(z) = (A_{i2}(z)k_{i2}(z)^\alpha l_{i2}(z)^{1-\alpha})^{1-\theta_2} x_{i1}(z)^{\theta_2} \quad z \in [0, 1]$$

- $A_{i1}(z)$ ,  $A_{i2}(z)$  (TFP) determine comparative advantage. TFPs are drawn from Frechét probability distribution (Eaton and Kortum (2002)):

$$F(A_i) = e^{-TA_i^{-n}} \quad i = H, F$$

- With two stages and two countries, there are 4 ways that each stage 2 consumption could be made.

## Production and Technologies: II

- Stage 2 consumption goods are costlessly assembled to produce aggregate non-traded good used for consumption and as an intermediate in production:

$$X_i = \exp \left[ \int_0^1 \ln(x_{i2}(z)) dz \right] = C_i + M_i$$

- Aggregate investment good is produced similarly to above, but in just one stage

# Trade Barriers

- Only sources of distortions in model are three trade costs: tariffs, transport costs, and all other trade costs
- Tariffs,  $(1 + b_{ijx})$ , are ad valorem; tariff revenue is rebated to households as lump sum transfers.
- The latter two costs are modeled as ad valorem iceberg costs, i.e., to receive 1 unit,  $(1 + tr_{ijx})(1 + d_{ijx})$  units must be shipped.
- Total trade costs to ship a good of type  $x$  from country  $i$  to country  $j = 1 + \tau_{ijx} = (1 + b_{ijx})(1 + d_{ijx})(1 + tr_{ijx})$
- Trade costs differ across countries, and across "types" of goods, but within each type, they are identical across goods



# Household Maximization

- Preferences

$$\sum_{t=0}^{\infty} \beta^t \frac{C_{it}^{1-\sigma} - 1}{1-\sigma}$$

- Intertemporal elasticity of substitution =  $1/\sigma$
- Representative household supplies labor and rents out capital to firms. It chooses consumption and investment paths
- Budget constraint (period-by-period):

$$P_{it}C_{it} + P_{ilt}I_{it} = w_{it}L_{it} + r_{it}K_{it} + T_{it}; \quad t = 1, \dots, \infty$$

# Trade

Consider a special, symmetric case in which labor is the only factor of production, goods are made from one stage, and productivity distributions are same across countries. Then, the import share of GDP is:

$$\frac{1}{1 + (1 + \tau)^n} \quad (1)$$

# Magnification Effect from Multi-Stage Production

- Consider a special symmetric case in which aggregator firms in country  $H$  must buy stage 2 goods whose stage 1 component was made in  $H$ .
- In this case, the import share of GDP is:

$$\frac{\varphi}{1 + (1 + \tau)^n \left( \frac{1 + \theta_2}{1 - \theta_2} \right)} \quad (2)$$

- Note how all trade costs enter with a  $1 + \theta_2$  term in the numerator, and a  $1 - \theta_2$  term in the denominator of the exponent. Reduction in tariff rates (and other trade costs) has magnified effect on trade.

# Magnification Effect from Multi-Stage Production

Two forces underlie the magnification effect:

- 1 Back-and-forth trade leads at least some stages to bear multiple trade costs  $((1 + \theta_2))$
- 2 Marginal production stage is the 2nd stage, but trade cost is applied to entire good. Hence "effective" trade cost is the trade cost divided by the share of the 2nd stage in the total cost  $(\frac{1}{1-\theta_2})$ .

# Growth, Income, and Welfare

- Focus on income per capita in zero growth steady-state.
- Lower Korean tariffs on consumption goods adversely impacts Korea's terms of trade and **reduces** Korea's output measured in units of foreign consumption good.
  - Output at base-year prices may rise.
- Welfare may rise owing to increased specialization and additional output from capital accumulation.

# Growth, Income, and Welfare

- Lower Korean tariffs on investment goods adversely impacts Korea's terms of trade as before, but also leads to greater capital accumulation:

$$\frac{r_{h,ss}}{P_{hl,ss}} = \frac{1}{\beta} - (1 - \delta)$$

- Lower tariffs on investment goods reduce  $P_{hl,ss}$  from a direct channel and an external margin channel.
  - Direct channel: existing imports are cheaper
  - External margin channel: import a greater fraction of goods.
- Capital accumulates,  $r_{h,ss}$  declines, until decline in  $r_{h,ss}$  matches decline in  $P_{hl,ss}$ .
- Terms of trade effect on output may be offset by capital accumulation effect, and specialization effect.
- Welfare more likely to be higher in new steady-state.

# Growth and Income

- Increased specialization and increase in capital stock show up partly as aggregate TFP gains.
  - Productivity of individual goods has not changed, but economy is using resources more efficiently.
  - Also, under Hall/Jones and Klenow/Rodriguez-Clare, TFP contributions are larger.

# Calibration

- 1 Korea and G7 countries
- 2 Focus on manufacturing sector only
- 3 Trade costs are only distortions
- 4 Compute initial steady-state with 1962/1963 tariffs. Then compute steady-state with new (1989) tariff rates. Compare results to 1995 data.
- 5 Interpretation: Korea is initially in steady-state in 1962/1963. Current tariff rates are expected to persist forever. In 1962, new path for tariffs for Korea and G7 are announced. The path is the tariff level in 1989. Agents assume these tariff rates persist forever. New steady-state is reached in 1995.



# Calibration

Parameter/Variable	Value
Korea labor relative to G7 labor (average over 1963-1995)	0.047
Capital share of value-added	0.4
Intermediate input share in production	0.67
Transport costs	0.092
Tariff rate, Korea, 1962 and 1989	0.399, 0.127
Tariff rate, G7, 1962 and 1989	0.1395, 0.05

- Productivity parameters:
  - Assume no relative advantage in stage-1 versus stage-2 production.
- Depreciation rate on capital: 0.1
- Preference discount factor: 0.96

# Calibration of Frechet Heterogeneity Parameter

- 1 Estimates of elasticities from trade models range from 5-10.
  - 1 In standard Eaton-Kortum model, this elasticity =  $n$
- 2 Following Edmond, Midrigan and Xu (2012), we compute partial elasticity  $d \ln((1 - \lambda)/\lambda) / d\tau = -n$ , where  $1 - \lambda$  is the trade share.
- 3 We solve for  $n$  that yields trade elasticity of 9.29 (Caliendo and Parro (2014)).
  - 1 This yields:  $n = 3.75$ .

# Calibration

Set productivity parameters and "all other" trade costs to match: Korea's initial export share of GDP, ratio of Korea to G7 manufacturing VA per worker, Korea's consumption share of imports, and Korea's imported investment share of GDP

Variable	Target	Value
$\left( \frac{T_{Korea,C}/L_{Korea}}{T_{G7C}/L_{G7}} \right)$	$\frac{Y_{Korea}/L_{Korea}}{Y_{G7}/L_{G7}}$ (0.17)	0.146
$\left( \frac{T_{Korea,I}/L_{Korea}}{T_{G7,I}/L_{G7}} \right)$	Export share of GDP (0.15)	0.091
$tr_{G7K,C2}$	Consumption share of imports (0.025)	0.647
$tr_{ij,I}; tr_{ij,C1}; tr_{KG7,C2}$	Imported invest. share of GDP (0.040)	0.129

# Calibration of Tariff Exemption for Imported Inputs and Capital Goods used for Export Production

## 1 Imported inputs

- 1 Each consumption good can be produced in four ways. One way (Korea imports first stage goods from G7, uses them to make second stage, which is then exported back to G7) is relevant for tariff exemption.

## 2 Imported capital goods

- 1 These goods must be part of capital stock devoted only to export production.
- 2 Implement in model by creating a second capital stock.
- 3 Budget constraint:

$$P_{Kt}C_{Kt} + P_{KIt}I_{Kt} + P_{KIt}^E I_{Kt}^E = w_{Kt}L_{Kt} + r_{Kt}K_{Kt} + r_{Kt}^E K_{Kt}^E + T_{it} \quad (3)$$

# Main Results

Variable	$\frac{Y_{Kt}/L_{Kt}}{Y_{G7t}/L_{G7t}}$	$\frac{X}{Y}$	$\frac{I_M}{Y}$	$\frac{C_M}{M}$
Actual data (1963)	0.171	0.15	0.04	0.025
Actual data (1995)	0.395	0.92	0.42	0.095
Actual growth rate (logs)	<b>0.837</b>	<b>1.84</b>	<b>2.36</b>	<b>1.33</b>
Trade policy reform	(log) growth rate implied by model			
(1) Tariff exemption	0.0837	0.67	0.64	-0.51
(2) Korea tariff reduction	-0.0397	1.14	1.06	-0.027
(3) GATT tariff reduction	0.0928	0.38	0.35	-0.020
(2)+(3)	0.0812	1.44	1.29	0.022
(1)+(2)+(3)	0.123	1.73	1.55	-0.27
Note: $Y$ , GDP; $L$ , labor; $X$ , exports; $M$ , imports; $I_M$ and $C_M$ , imported inv and con;				

# Welfare

Variable	$\frac{Y_{Kt}/L_{Kt}}{Y_{G7t}/L_{G7t}}$	$\frac{C}{L}$
Actual data (1963)	0.171	
Actual data (1995)	0.395	
Actual growth rate (logs)	<b>0.837</b>	
Trade policy reform	(log) growth rate implied by model	
(1) Tariff exemption	0.0837	0.044
(2) Korea tariff reduction	-0.0397	0.075
(2a) Korea C tariff reduc	-0.056	0.046
(2b) Korea I tariff reduc	-0.0062	0.028
(3) GATT tariff reduction	0.0928	0.061
(2)+(3)	0.0812	0.163
(1)+(2)+(3)	0.123	0.174

# Role of Imported Investment Goods and Multi-Stage Production

Variable	$\frac{Y_{Kt}/L_{Kt}}{Y_{G7t}/L_{G7t}}$	$\frac{X}{Y}$	$\frac{I_M}{Y}$	$\frac{C_M}{M}$	$\frac{C}{L}$
Actual data (1963)	0.171	0.15	0.04	0.025	
Actual data (1995)	0.395	0.92	0.42	0.095	
Actual growth rate (logs)	0.837	1.84	2.36	1.33	
Trade policy reform (1)+(2)+(3)	(log) growth rate implied by model				
	<b>0.123</b>	<b>1.73</b>	<b>1.55</b>	<b>-0.27</b>	<b>0.174</b>
(1)+(2)+(3) w/o imp inv	0.075	1.69	0.00	-0.23	0.132
(2)+(3)	<b>0.0812</b>	<b>1.44</b>	<b>1.29</b>	<b>0.022</b>	<b>0.163</b>
(2)+(3) w/o multi-stage	0.0388	1.36	1.19	0.867	0.079
(2)+(3) w/o m-s and imp inv	-0.0526	1.80			0.026
Note: $Y$ , GDP; $L$ , labor; $X$ , exports; $VS$ , vertical specialization; $I_M$ and $C_M$ , imported inv and con;					

# Vertical Specialization

Variable	$\frac{VS}{Y}$	$\frac{VS}{Y}$
	1963	1995
Actual data	0.0494	0.289
Model		
Initial steady-state	0.0075	
(1) Tariff exemption		0.0306
(2) Korea tariff reduction		0.0613
(2a) Korea C tariff reduc		0.0590
(2b) Korea I tariff reduc		0.0078
(3) GATT tariff reduction		0.0168
(2)+(3)		0.117
(1)+(2)+(3)		0.215



# Implications for TFP

- Growth accounting shows that 87% of Korea's output growth (measured in Korean consumption units) from three trade reforms is accounted for by TFP with remainder accounted for by K/Y.
  - Same as in the data.

## Summary of Results and Interpretation

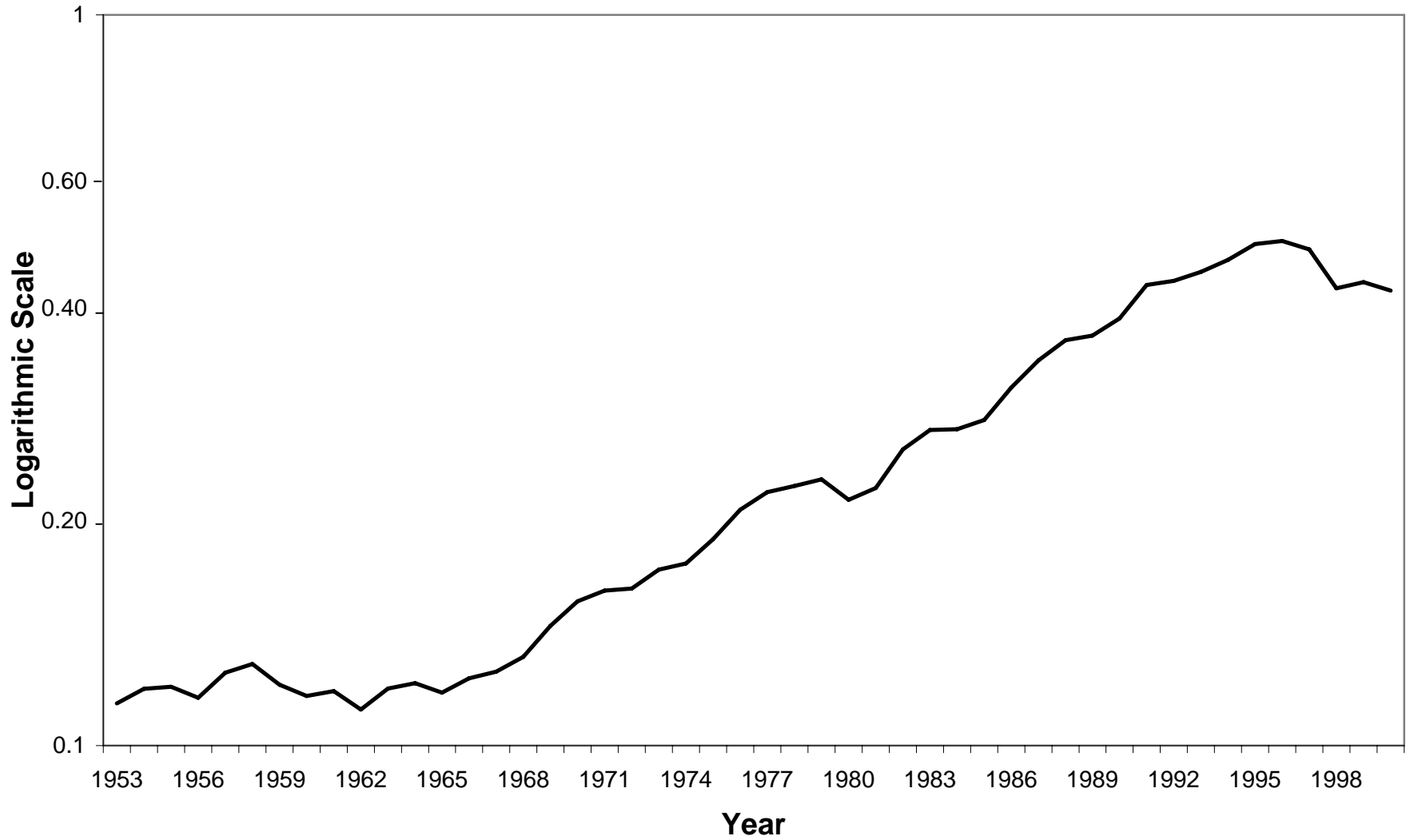
- Three trade reforms explain 18 percent of Korea's catch-up to G-7 in manufacturing value-added per worker
- Imported investment and multi-stage production channels explain virtually all of the model's catch-up in relative value-added per worker
  - Explain about 5/6 of the model's implied growth in consumption per worker.
- Growth accounting shows that 87% of gains from three reforms are from TFP and 13% are from K/Y.
- If additional trade channels are included, catch-up would likely be larger
  - Learning-by-doing
  - Technological spillovers
  - Human capital accumulation

# Conclusion

Two extensions:

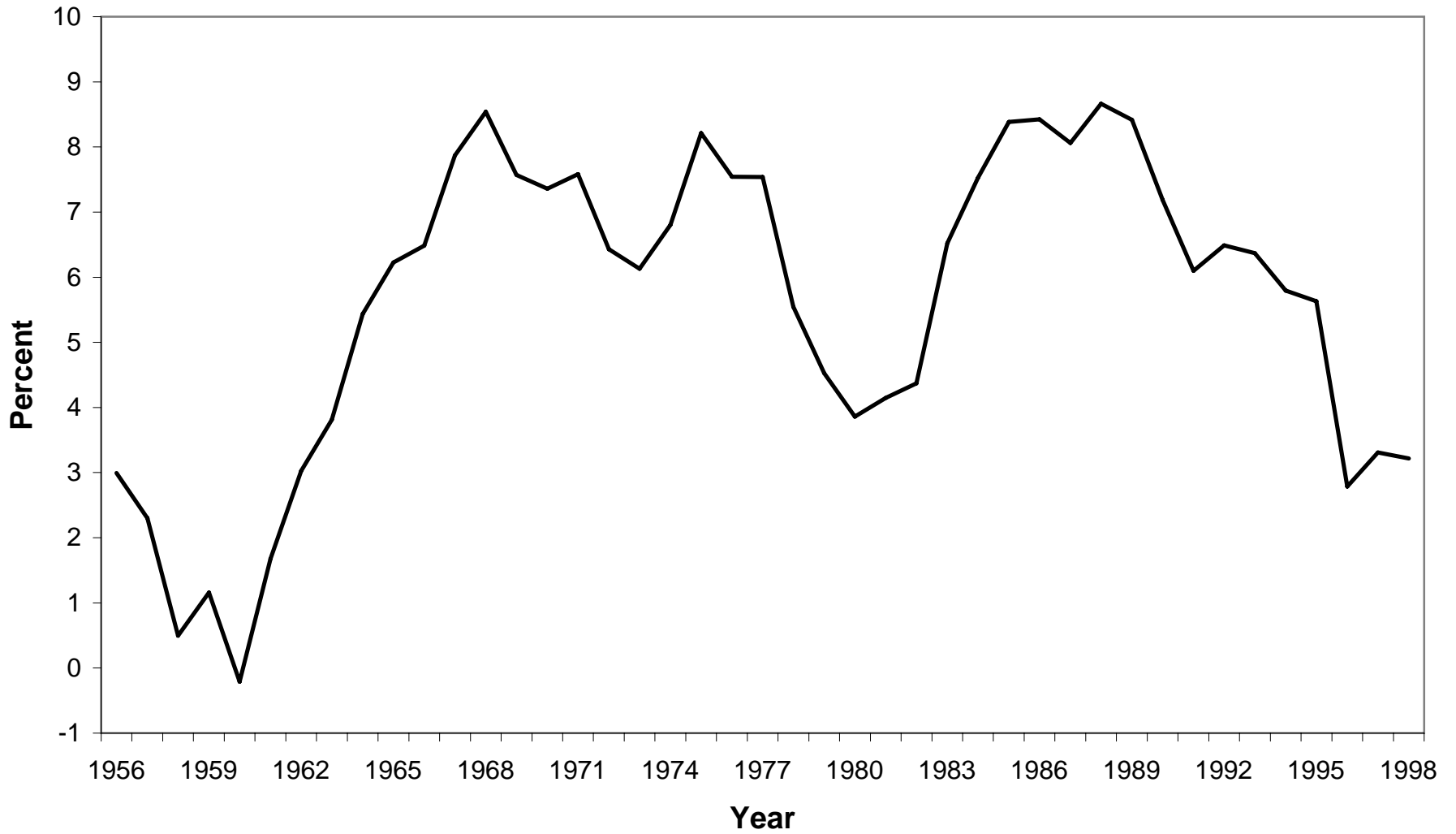
- Include additional policy reforms:
  - Include fiscal policies, e.g., exporters paid lower corporate income taxes
  - Include credit policies, e.g., exporters received low interest rate loans
- Endogenize technology gains

## Ratio of South Korea GDP per Capita to US GDP per Capita



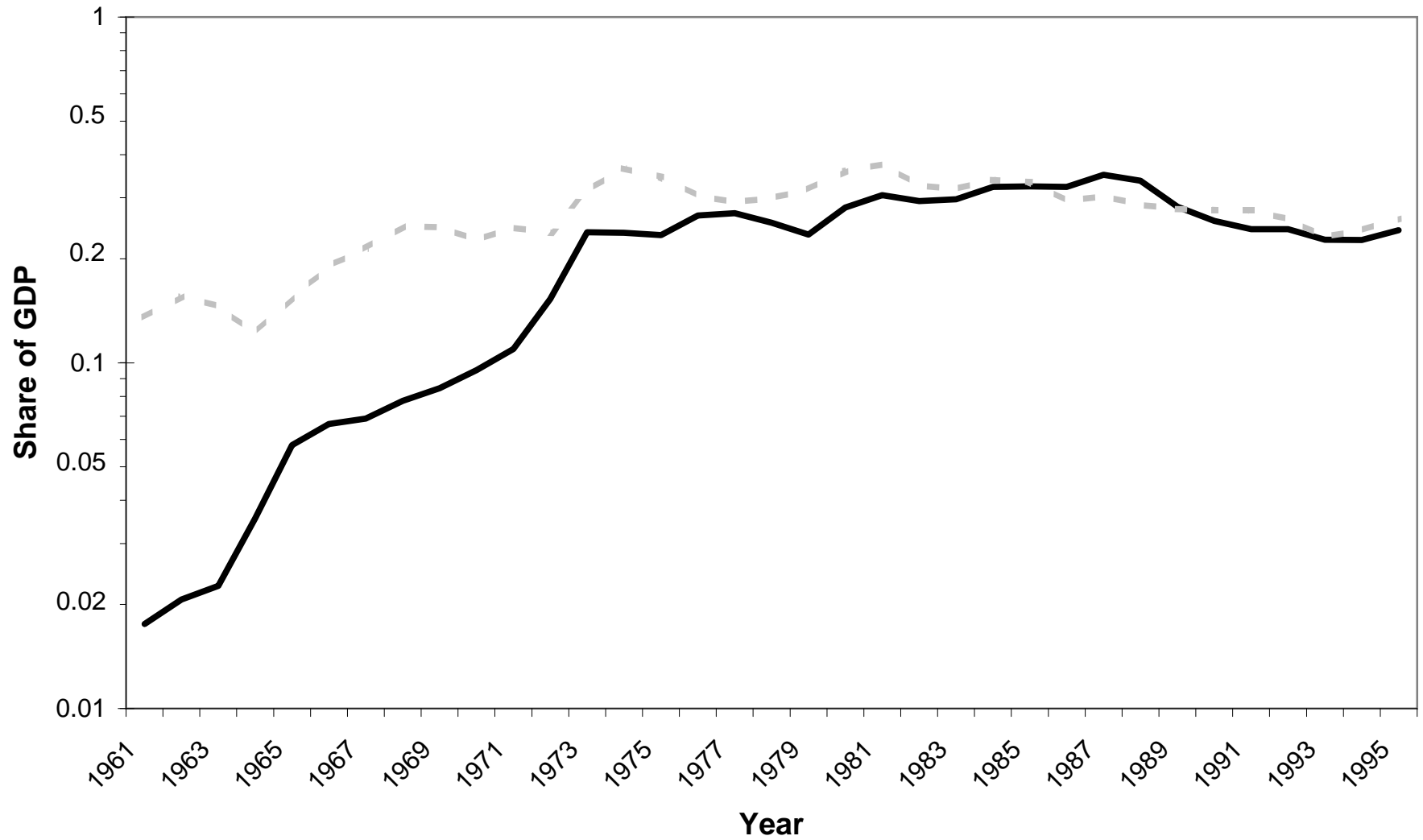
Source: Penn World Tables, 6.1

**South Korea: GDP per Capita Growth**  
Five-year Centered Moving Average



Source: Penn World Tables, 6.1

## South Korea's Exports and Imports (Merchandise)



# Effective Incentive Rates for Manufacturing Industries in 1968

Type of Industry \ Incentive rates (percent)	Exports	Non-exports
Non-import competing	-4.6	-32.4
Export	0.8	-33.9
Import competing	12.4	64.1
Export and import competing	-4.9	35.4
Average	-0.3	-19.2
Source: Westphal and Kim (1977)		

## Context: Empirical Literature on Trade and Growth

- Early empirical work showed strong correlation between export growth and per capita GDP growth
- Cross-country growth regressions: trade not robustly significant
- More recent research more careful and focuses on trade policy, e.g., Sachs and Warner (1995)
- However, Rodriguez-Rodrik (2000) shows that even this research has problems: measurement; specification, robustness
- R-R conclude: "skeptical ... strong negative relationship between trade barriers and economic growth."

Note: R-R do not dispute beneficial effects of trade liberalization, but they argue it is not a panacea. Also, Wacziarg and Welch (2008) address many, but not all, of the R-R critiques.



# Rodriguez-Rodrik's Prescriptions

- 1 Study "the channels through which trade policies influence economic performance"
- 2 "Look for contingent relationships between trade policy and growth"
- 3 "Microeconometric analysis of plant-level data sets"  
Our work is consistent with 1 and 2

# Context: Trade and Growth Theory

- In past two decades, new models – endogenous and semi-endogenous – developed to explain linkages from trade policy to long run income levels and/or growth rates.
- However, these models have not been typically applied to actual growth experiences
- We employ neoclassical framework as benchmark

# Prices (1)

The price that a consumption good stage 2 firm  $z$  in country  $F$ , pays for a stage 1 good =

$$p_{F1}(z) = \min \left[ \frac{\psi(1 + \tau_{HF1})(r_H^\alpha w_H^{1-\alpha})^{1-\theta_1} P_H^{\theta_1}}{A_{H1}(z)^{1-\theta_1}}, \frac{\psi(r_F^\alpha w_F^{1-\alpha})^{1-\theta_1} P_F^{\theta_1}}{A_{F1}(z)^{1-\theta_1}} \right] \quad (4)$$

The price that a consumption aggregator firm in country  $H$  pays for a stage 2 good  $z$  =

$$p_H(z) = \min \left[ \frac{\psi(r_H^\alpha w_H^{1-\alpha})^{1-\theta_2} p_{H1}^{\theta_2}(z)}{A_{H2}(z)^{1-\theta_2}}, \frac{\psi(1 + \tau_{HF2})(r_F^\alpha w_F^{1-\alpha})^{1-\theta_2} p_{F1}^{\theta_2}(z)}{A_{F2}(z)^{1-\theta_2}} \right] \quad (5)$$

## Prices (2)

- The overall price level for the aggregate consumption good in country  $H$  is:

$$P_H = \exp \left( \int_0^1 \ln(p_H(z)) dz \right)$$

- If tariffs are reduced, the overall price level falls for two reasons:
  - The stage 2 goods that are already imported become cheaper.
  - More stage 2 goods are imported.

# Initial Steady-State

## Initial Steady-State

Variable	$\frac{Y_K/L_K}{Y_{G7}/L_{G7}}$	$\frac{X}{Y}$	$\frac{Inv_M}{Y}$	$\frac{Con_M}{M}$	$\frac{VS}{Y}$
Actual data (1963)	0.17	0.15	0.040	0.025	0.0494
Initial steady-state	0.17	0.15	0.040	0.025	0.0075

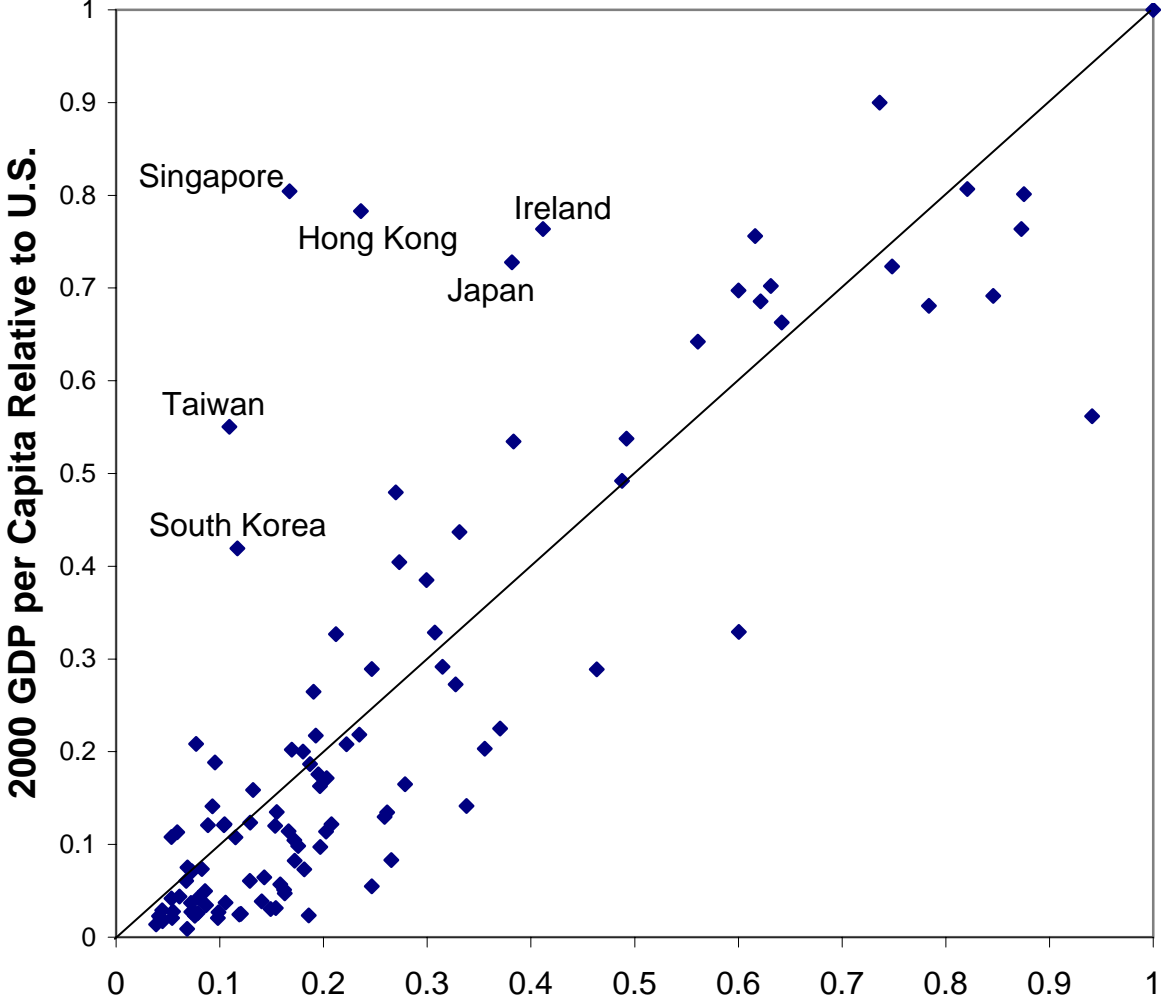
Note:  $Y$ , GDP;  $L$ , labor;  $X$ , exports;  $VS$ , vertical specialization;  $Inv_M$  and  $Con_M$ , imported investment and consumption;

# Effective Incentive Rates for Manufacturing Industries in 1968

Type of Industry	Exports	Non-exports
Non-import competing	-4.6	-32.4
Export	0.8	-33.9
Import competing	12.4	64.1
Export and import competing	-4.9	35.4
Average	-0.3	-19.2

Source: Westphal and Kim (1977)

### 1960 and 2000 per-Capita GDP Relative to U.S.



Source: Penn World Tables, 6.1

1960 GDP per Capita Relative to U.S.

## Hall-Jones Decomposition of S. Korea GDP per worker Output per Worker relative to U.S. GDP per Worker

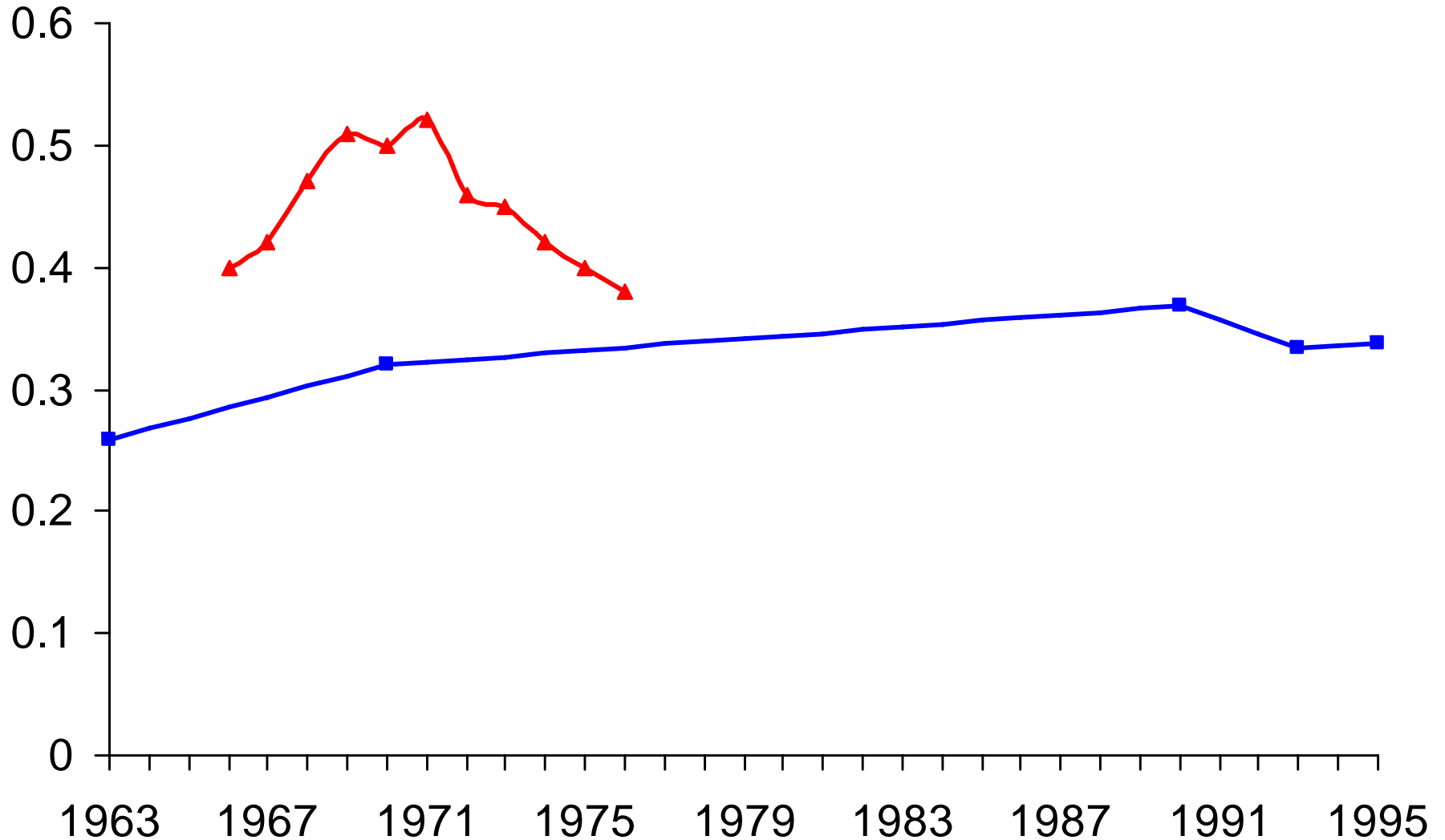
	$Y / L$	$(K/Y)^{\alpha/(1-\alpha)}$	$H / L$	$A$
1960	.148	.804	.576	.319
1995	.580	1.115	.868	.600
% Contribution To Change 1965-1995		23.9	29.9	46.2

Note: Capital Growth rate = .031, the growth rate of investment spending from 1955-1962  
Source: PWT, 6.1



# Korea's Vertical Specialization Exports

Share of merchandise exports



Source: Hummels, Ishii, Yi (2001), Hong (1979)

# US Exports As a Share of Merchandise Exports

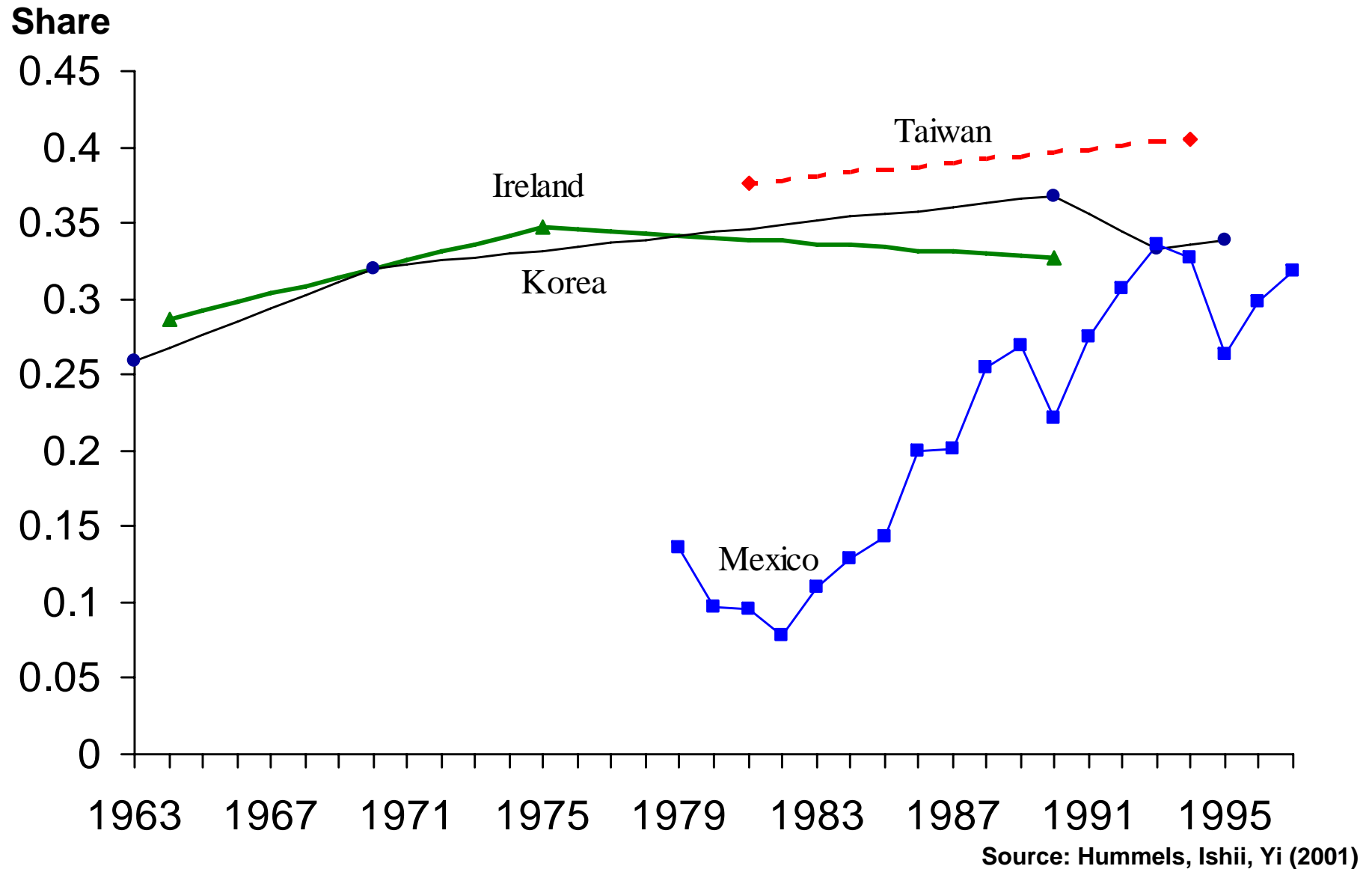
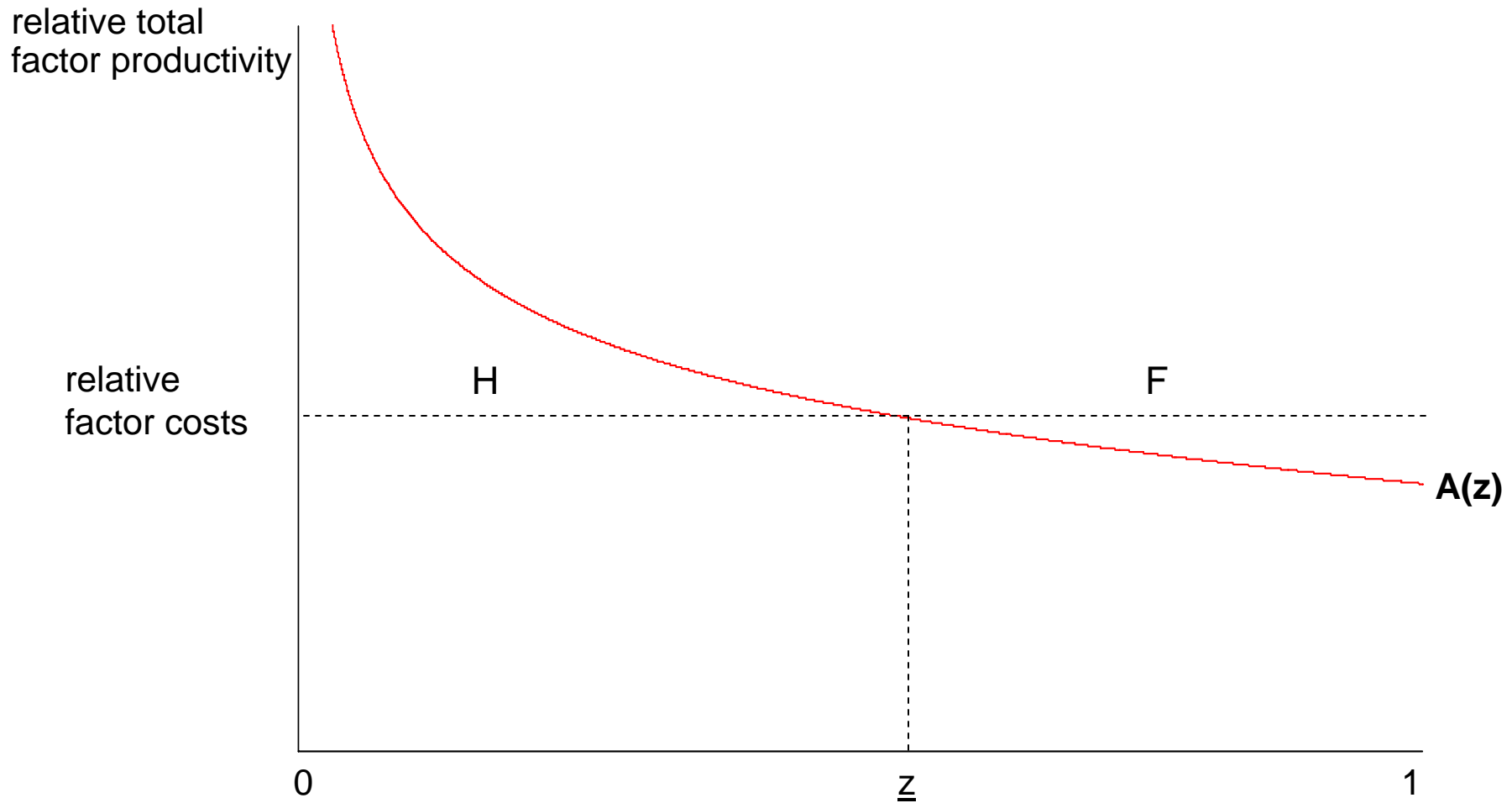


Figure 3

# Two-Country Eaton-Kortum (or Dornbusch-Fischer-Samuelson) Model

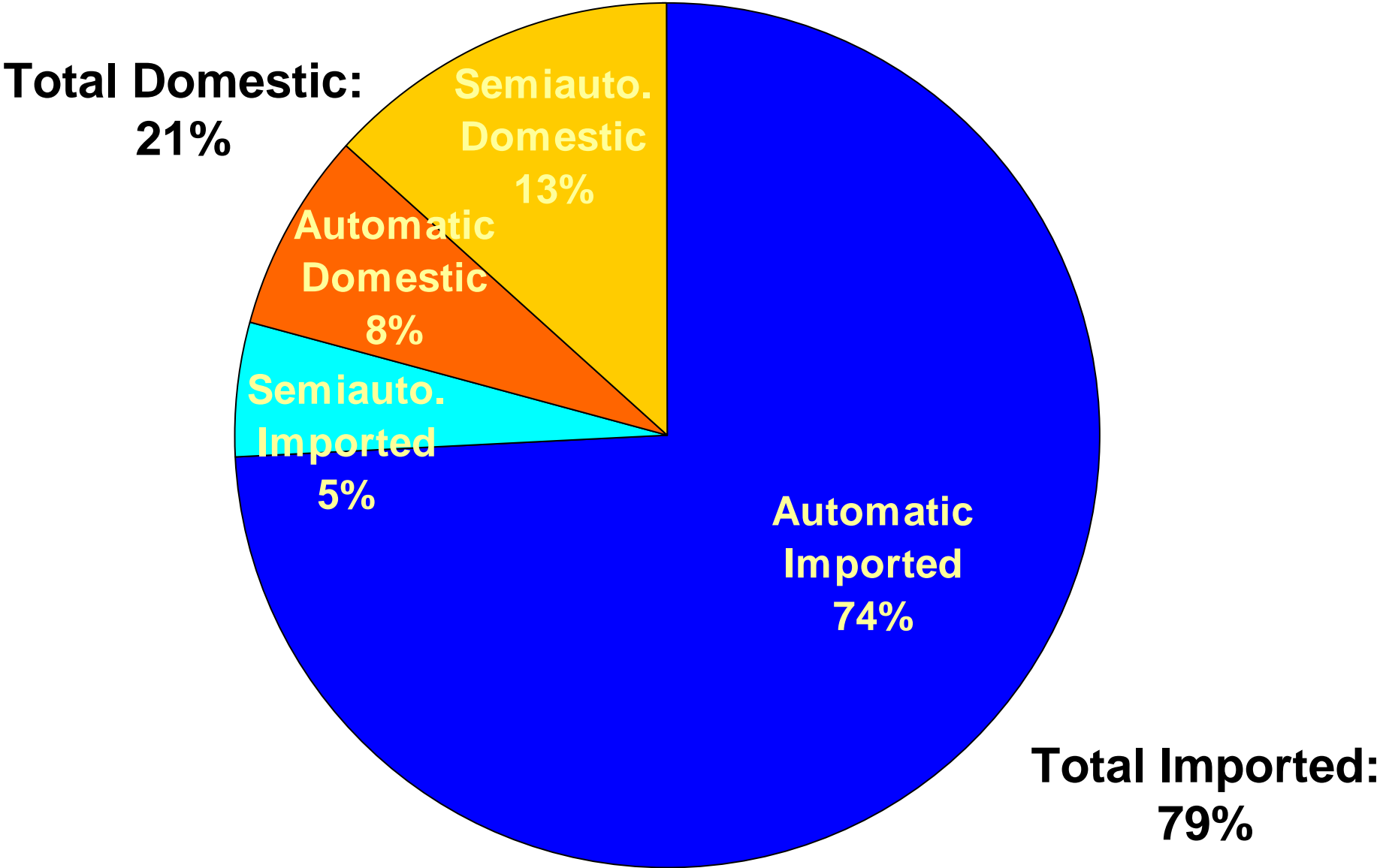


## Hall-Jones Decomposition of S. Korea GDP per worker Output per Worker relative to U.S. GDP per Worker

	$Y / L$	$(K/Y)^{\alpha/(1-\alpha)}$	$H / L$	$A$
1965	.147	.814	.640	.282
1995	.580	1.115	.868	.600
% Contribution To Change 1965-1995		22.9	22.1	54.9

Note: Capital Growth rate = .031, the growth rate of investment spending from 1955-1962  
Source: PWT, 6.1

# Loom Study: Sample Composition



Imported automatic looms on average more efficient (and also more expensive) than those produced domestically

Loom Type	Automatic		Semiautomatic	
Origin Of Loom	Domestic	Imported	Domestic	Imported
Avg. Cost ('000 won)	305	719	175	93
Looms per operator	10	18	6	4
Annual Power Cost	5.1	13.4	.8	.4

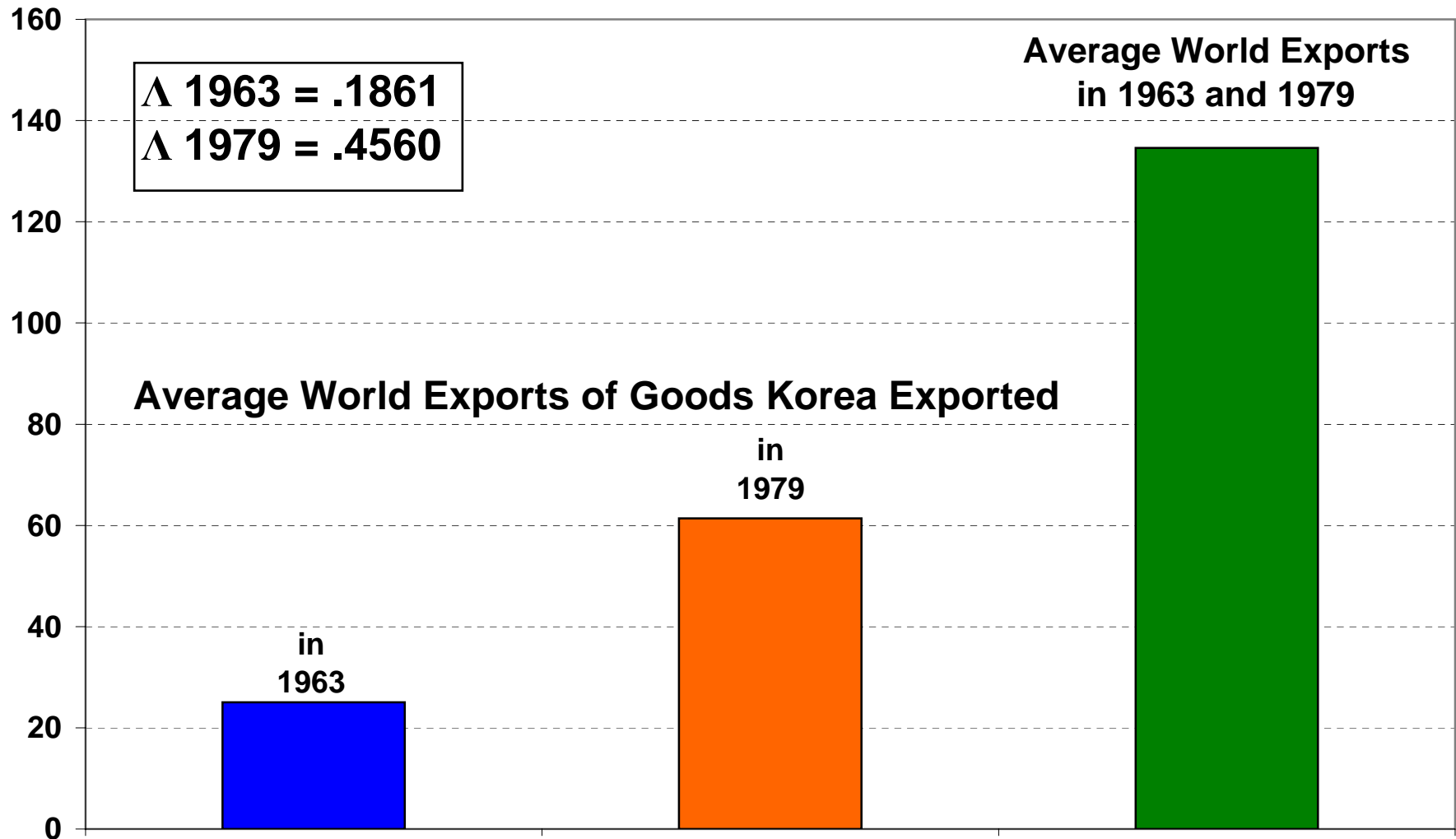
# And cloth produced by imported looms more likely exportable\*

Loom Type	Automatic		Semiautomatic	
Origin Of Loom	Domestic	Imported	Domestic	Imported
Share of Products Exportable	50.0	87.8	13.8	20.0
Share Exported*	33.3	58.5	9.2	13.3

\*Note that 'exportable' indicates high quality, and these products are also in demand at home. From a small sub-sample, Rhee and Whestphal (1977) estimate that 2/3 of all exportable products are actually exported.

# Korea's Export Variety Between 1963 and 1979

Billion US \$



Source: UN COMTRADE

Note: Feenstra-Kee methodology; Averages are of World Exports to the United States



## Hummels-Klenow Extensive and Intensive Margins for Korea

<u>Country Set</u>	<u>Year</u>	<u>Extensive Margin</u>	<u>Intensive Margin</u>
Group A*	1963	0.082	0.012
	1968	0.210	0.016
	1973	0.376	0.026
	1983	0.506	0.035
	1993	0.785	0.030
	1995	0.776	0.032
Group B**	1973	0.349	0.024
	1983	0.488	0.033
	1993	0.761	0.030
	1995	0.761	0.032
Group C***	1995	0.752	0.034

Extensive Margin is the ratio of world exports in industries where Korea has positive exports to total world exports.

Intensive Margin is the ratio of total Korean exports to world exports in industries where Korea has positive exports.

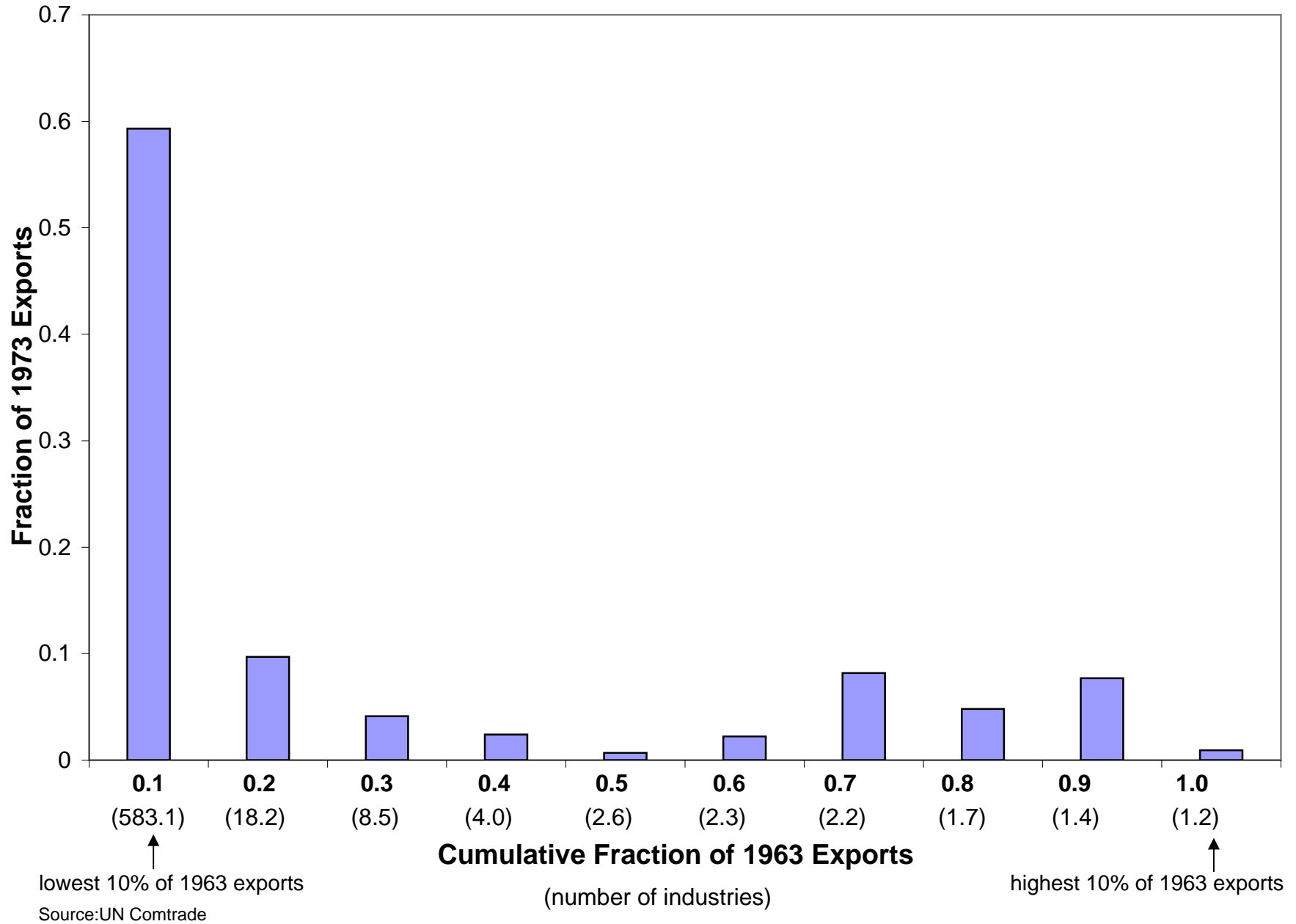
\* Set contains 14 countries

(Argentina, Australia, Belgium, Brazil, Canada, France, Hong Kong, Italy, Japan, Netherlands, Norway, Peru, Spain, and United States)

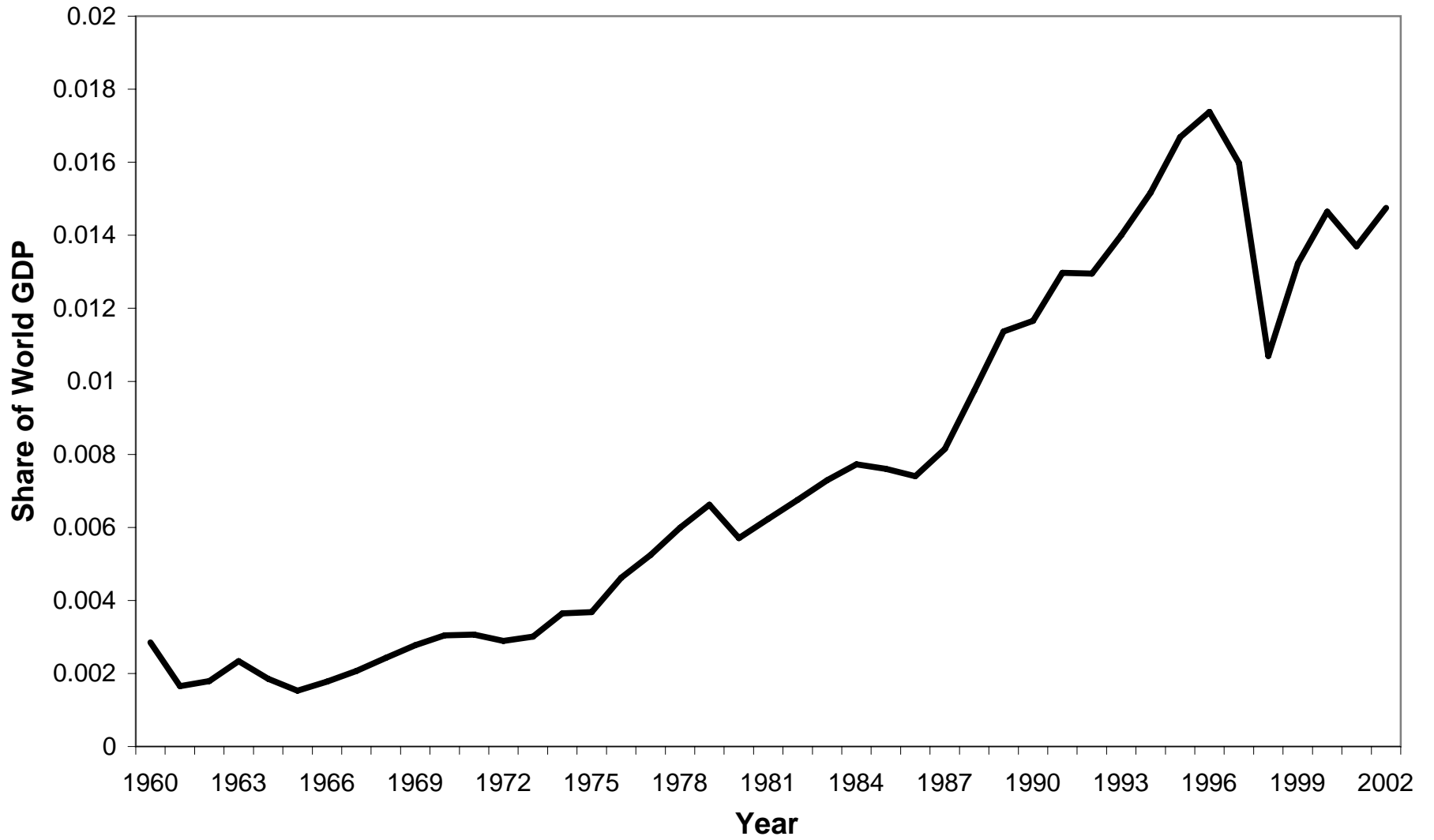
\*\* Set contains 32 countries

\*\*\* Set contains 60 countries

## South Korea Export Variety Expansion: 1963-1973

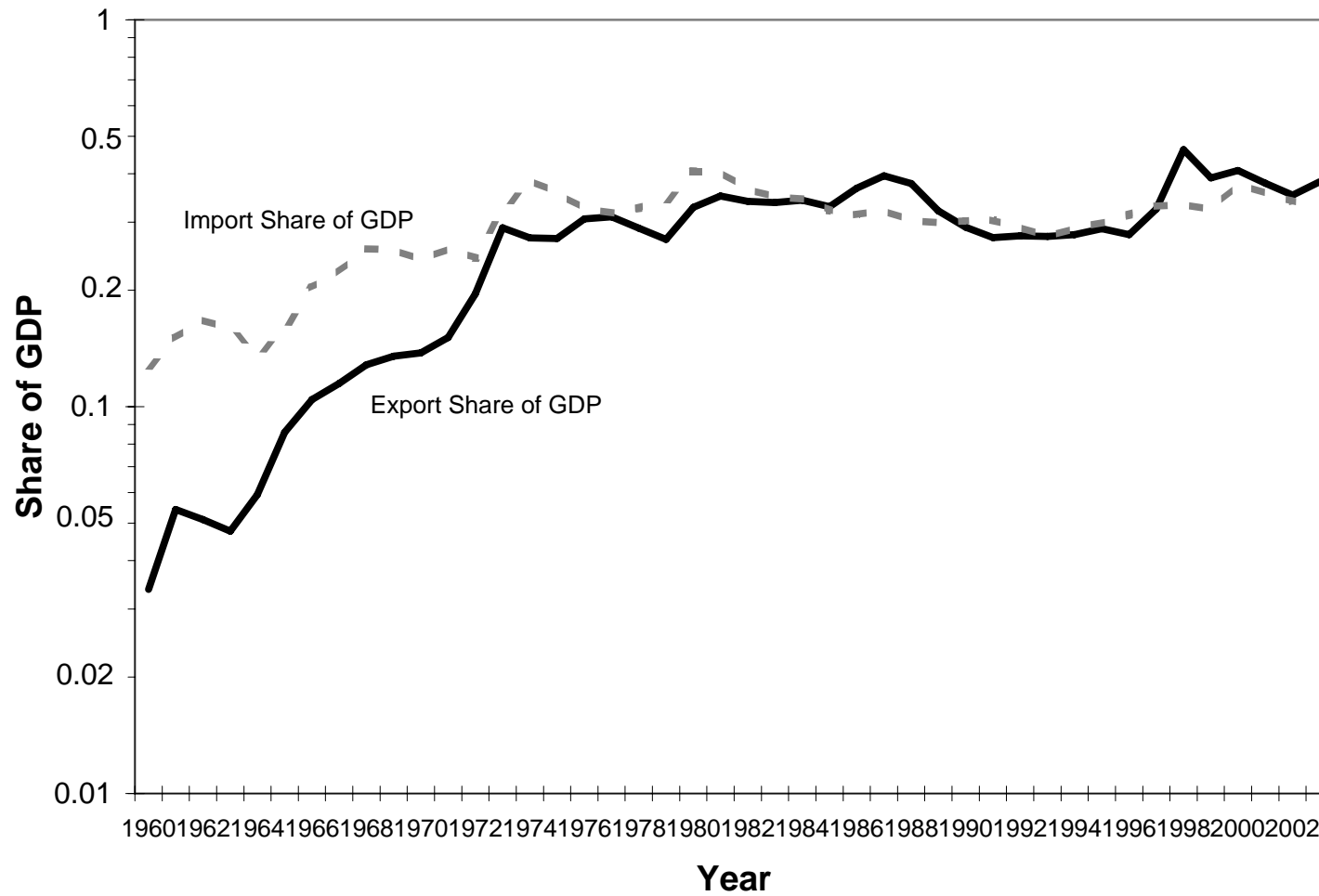


### South Korea's GDP as a Share of World GDP



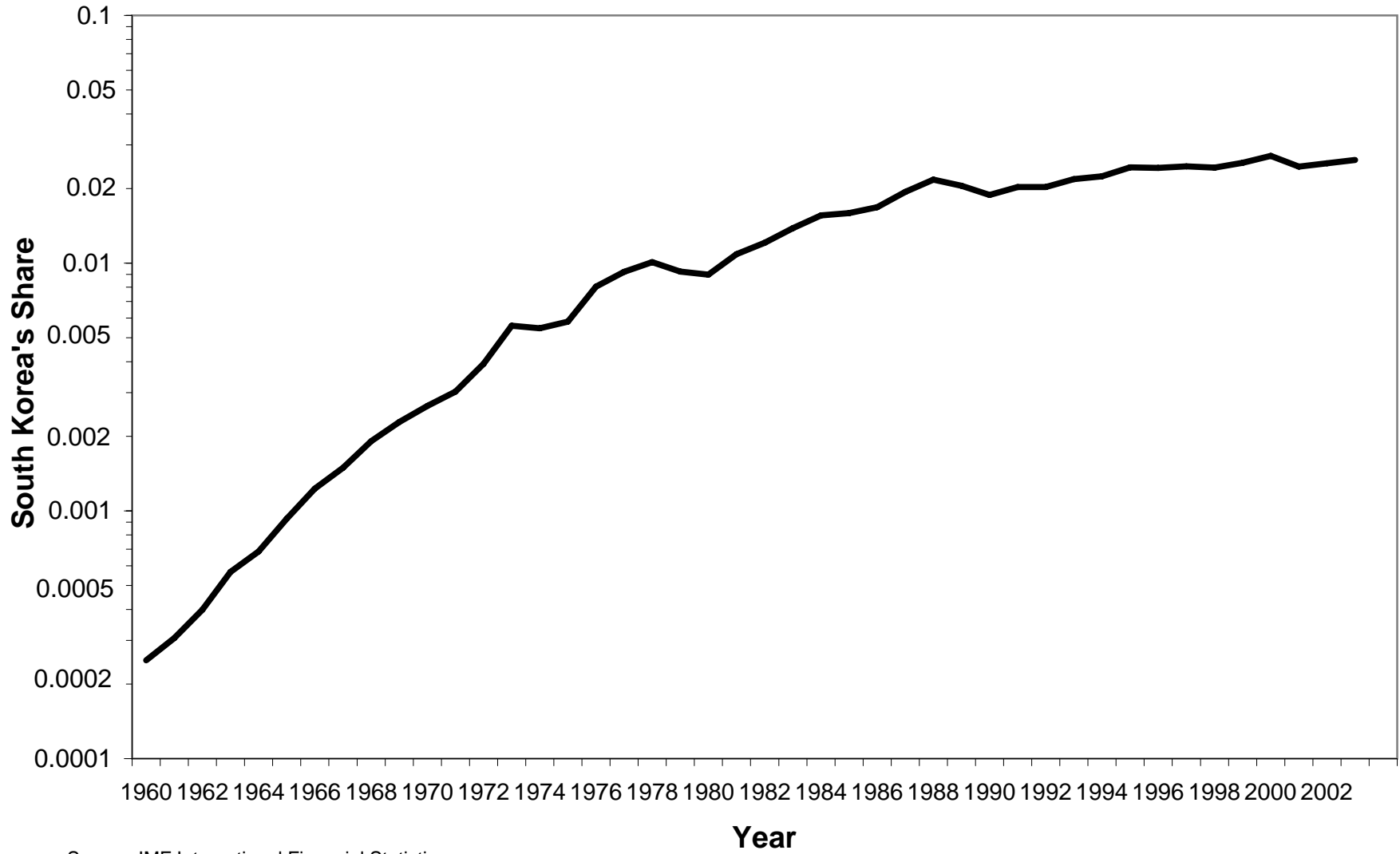
Source: World Development Indicators

## South Korea's Exports and Imports (Goods and Services)



Source: IMF International Financial Statistics

## South Korea's Exports as a Share of World Exports



Source: IMF International Financial Statistics